A DIGITAL PLANET FOR SUSTAINABILITY

In support of the UN Secretary General's Roadmap on Digital Cooperation

ZERO ORDER DRAFT

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I. Introduction

Humanity is standing on the edge of a cliff. For the first time in human history, we know we face an unfathomable choice: continue to destabilise the planet and risk losing our life support system or transform the future of humanity.

The COVID-19 pandemic has revealed our society's vulnerability to complex global challenges, as well as our potential to meet them. It has presented humbling lessons about our geopolitical weaknesses and our outdated models of economic growth, as well as the inadequacy of short-term profit-oriented solutions to address deeply rooted global governance challenges. It has also illuminated the multifaceted phenomenon of a global society that is hyperconnected and increasingly reliant on information systems, digital technology, and related infrastructure.

At the same time, the global cooperation seen in response to COVID-19 demonstrates the potential of open science – the unprecedented sharing of ideas and data within and beyond the scientific community and across the public-private interface, accelerated by digital technologies. The scientific community's contribution to the pandemic response – from initial gene sequencing to effective vaccines in less than a year and garnering public trust in the process – illustrates the profound capacity of modern science and technology to quickly address major crises when the global commons is urgently prioritised.

But we face a paradox as the world undergoes digital transformation. On the one hand, the economy is becoming digitalized at an unprecedented speed and scale. The tools of digital transformation enable us to understand and manage, as never before, the complexities of earth's dynamic systems and the way they enfold humanity. Digital technologies also affect human wellbeing by enhancing capacities to share, innovate, and participate in our communities. On the other hand, we are not yet using that technology to build a truly sustainable civilisation. In fact, our degradation of the planet is accelerating.

Digital technologies have brought about unprecedented scaling of connectivity and information sharing that, when combined, can act as accelerators in our attempts to accomplish the changes necessary to achieve environmental sustainability. A 2019 expert review conducted by Future Earth[1] identified four digitally empowered capabilities already disrupting our economic, governance, and cognitive systems at a global scale: "unprecedented levels of transparency, intelligent systems, mass collaboration, and mixed reality." These digitally empowered capabilities can provide a pathway to sustainability – but this is not a given, nor is it sufficient.

Digitalization must be actively channeled through conscious choices and deliberate, strategic intent to achieve planetary sustainability. Otherwise, we risk irreparable deterioration of the environment, the economy, and society at large. Ultimately, as we make conscious choices to guide digital transformation, we must rethink the values, incentives, and business models that have led to the degradation of the planet and our relationship with nature.
So far, the haphazard way that digitalization has progressed has proved to be an engine for scaling and amplifying existing global inequalities, including widening income gaps, deepening

[1] Sustainability in the Digital Age, "The Digital Disruptions for Sustainability (D^2S) Agenda: Research, Innovation, Action," Future Earth, 2020.

exclusion and discrimination, and diminishing agency. Reid Hoffman, the founder of LinkedIn, has remarked that nearly all digital business models actually depend on tapping into one or more of the seven deadly sins: pride, greed, lust, envy, gluttony, wrath, or sloth. Are these the values we want to amplify and accelerate? Is this the vision for a digital planet that we want?

COVID-19 has illustrated both the importance of connectivity, and the unequal distribution of digital access between and within countries. This has spurred momentum to recognise the basic human right of digital infrastructure in our increasingly digitized society. Doing so will be an essential start in eliminating an ever-widening digital inequality that reinforces existing social inequality.

The United Nations Secretary-General's Roadmap for Digital Cooperation calls on the international community to explore the ethical, legal, and human rights implications of our digitalized society. The Coalition for Digital Environmental Sustainability (CODES) emerged from this process as a means for advancing collective action in digitalizing environmental sustainability.

We are in a unique moment in time, where decisions we take now on how to restore environmental balances will set the course of our future prosperity and survival. We must understand how to successfully harness the range of digital technologies to respond, recover, and become more resilient in the face of increasing risk of environmental degradation, including threats from zoonotic diseases. The lessons we have learned from COVID-19 must inform our path toward environmental sustainability. The parallels hold fast: ignoring evidence, denying science, failure to mobilise a global response, and leaving behind those less fortunate will only lead to failure. Action cannot be undertaken by government alone; success depends on deep collaboration, trust, and transparency across civil society, governments, and the private sector.

Collective resolution must be urgently applied to protecting and restoring our planet and developing a respectful relationship with nature[2]. In an age where digital technologies have become a ubiquitous feature of society – with the potential to amplify (and disrupt) different divisions, worldviews, stakeholders, goals, processes and information – the human aspect of how our systems develop has become more important than ever.

Building on previous work[3,4,5], this report describes three primary, intertwined dynamics of the emerging and accelerating digital age. These are (1) reimagining the core incentives underlying models for business and society, (2) building sustainable digital infrastructure, and (3) shaping digital innovations toward a common vision. It offers the rationale for developing an acceleration

[2] United Nations Environment Programme (2021). Making Peace with Nature: A scientific blueprint to tackle the climate, biodiversity and pollution emergencies. Nairobi.

[3] WBGU. 2019. Towards Our Common Digital Future.

[4] IIASA, 2019. TWI2050 Report: The Digital Revolution and Sustainable Development: Opportunities and Challenges

[5] Sustainability in the Digital Age, "The Digital Disruptions for Sustainability (D^2S) Agenda: Research, Innovation, Action," Future Earth, 2020.

plan for digitally powered sustainability infrastructure, and for thriving, empowered, and connected livelihoods all over the world. It will offer milestones and a commitment framework to ensure that digital transformation supports, rather than undermines, a sustainable, equitable and just future. The ideas and thought-provoking questions presented in this report are not intended to be prescriptive; rather they are meant to inspire a new conversation on the pathways ahead – including some yet unexplored.

II. What's at stake

On our current trajectory, climate change, biodiversity loss, and pollution of the land, air, and oceans threaten to take us beyond the limits of the earth's capacity to sustain human life – with devastating consequences. Earth systems scientists have identified nine planetary boundaries, beyond which we will imperil human sustainability. These are climate change, ozone layer depletion, ocean acidification, chemical pollution, fertiliser use, freshwater withdrawals, land conversion, biodiversity loss, and air pollution. We have already crossed the threshold of four of the nine.[6]

This degradation of the planet results from the idea that our economic activity is restricted to exchanges between human actors. We must instead see human activity as one part of an exchange system among natural, social, and human capitals that is not exclusively centred on monetary profit – but achieves a balance between the value we provide to people and the planet.

The recently adopted framework on the System of Environmental Economic Accounting (SEEA), which better reflects the relationship between planetary wellbeing and human wellbeing, is a step in the right direction. But we must go further. Moving forward, it's vital that systems such as SEEA reflect nature's intrinsic value, and its value to us. Similarly, the 2020 Human Development Report and its experimentally adjusted Human Development Index, demonstrates how planetary and social imbalances reinforce each other and perpetuate inequalities, poverty, vulnerability and disempowerment. To survive and thrive in this new digital age, we must redesign and accelerate new pathways that respect, in the words of UNDP Administrator Achim Steiner, "the intertwined fate of people and planet, and that recognise that the carbon and material footprint of those who have more is choking the opportunities of the people who have less." Digital technology is no exception.

COVID-19 exposed the deep global inequality in the accessibility and availability of digitalization and the wide gap between the digitally connected and unconnected. While digital technologies supported many during months of lockdown, billions of people lacked the same safety and opportunities to work and learn from home. In fact, estimates suggest that around 47% of the global population[7], primarily from low- and middle-income countries and communities, lacks

[6] McSweeney, R. 2020. "Explainer: Nine 'tipping points' that could be triggered by climate change."

[7] WEF Accelerating Digital Inclusion in the New Normal, July 2020.

digital access. The lack of digital access inhibits empowered engagement, meaning that voices from low- and middle-income countries are heard less loudly in the global conversation. Closing the digital divide must be an urgent international priority that every governmental and multilateral body supports through legislation, investment, and a credible commitment to values-based globalisation.

Global power no longer resides primarily in nation states. It is also shared among distributed networks of governments, businesses, and civil society. Thus, our collective action on a global level can only be achieved if it is underpinned by a common and enabling digital infrastructure and trust. If we do this well, digital technology will be an essential force for good and a potential catalyst that propels sustainability forward.

This is one of the lessons we can take from the pandemic. But as the world bounces back from the pandemic, it's crucial that its shadow does not impede efforts toward sustainability. Pandemic recovery provides a crucial opportunity to close the digital divide in a manner that can also accelerate the achievement of the SDGs by the global community. It is also necessary to send the clear strategic signals and economic incentives that private and public sector actors need if they are to work together on achieving the massive technological, economic, and social transformations required on all fronts for the world to achieve the SDGs or including our existing net-zero carbon emissions targets – let alone a net-negative future – in a fair, just, and inclusive manner. In fact, the digital actions that we need to achieve this goal are extremely clear and straightforward.

III. Three Strategic Shifts

Now that we understand what's at stake, in this section we discuss the three intertwined dynamics toward which we must shift our collective efforts and attention to build a digital planet for sustainability. A successful approach will require a combination of data, standards, science, and technological infrastructure supported by values-based strategies and agile governance frameworks that position environmental sustainability and human wellbeing at the heart of digital solutions.

We introduce the three dynamics here, and discuss them in detail later on in this section.

1. **Reimagining the core incentives underlying models for business and society:** We must take action to shift leadership and business models and guide our technologies – digital and otherwise – with the values we want to reflect. Sectoral planning is not enough. A better understanding of our systems as a whole is critical to identifying drivers and incentives for change that can both influence and be influenced by digital channels.

2. **Building sustainable digital infrastructure:** Digital infrastructure is foundational to ensure digitalization benefits the whole of society. Infrastructure must be built in a way that ensures universal access and participation. And infrastructure must be designed so that its construction, operation, and disposal is sustainable and climate-safe.

3. **Shaping digital innovations toward a common vision:** Digital innovations are not only tools to help solve sustainability challenges. If they are based on shared values of responsibility, sustainability, resilience, solidarity, and humility, they can act as drivers of fundamental systemic changes.

These three dynamics will form the basic structure for the remaining sections of this paper. But as we take these global opportunities forward, we must also consider how to mitigate the risks of digital technologies and uncontrolled digital transformation.

While digital technologies are a vital piece of the planetary sustainability puzzle, we must address the fact that they are often developed, produced, and deployed in ways that are harmful. They fuel consumption, amplify environmental impact, use vast quantities of energy, entrench social divides, dislocate labour markets, and consolidate the power of the few over the many. Moving forward, we must work to ensure that continued digitalization and efforts to close the digital divide do not unintentionally amplify the drivers of climate change, biodiversity loss, and pollution of the air, soil, and oceans. Realising the positive potential of digital technology needs to go hand in hand with minimising negative impacts.[8]

(1) Reimagining the core incentives underlying business and leadership models

Key message: Leverage digital technologies to influence a shift in governance and leadership, and reimagine core incentives underlying key business models.

Scientists and environmentalists have warned of the consequences of the destruction of non-renewable and renewable natural capital since Rachel Carson's *Silent Spring* was published in 1962. Yet how much have the business models that drive the global economy actually shifted to reflect the overwhelming evidence presented by the scientific community? Of the $97 trillion USD in global financial capital, less than 2% is currently aligned to environment, social, and governance principles. How can we achieve planetary sustainability when 98% of our financial capital is focusing exclusively on maximising profit, without regard for our planet? We must acknowledge that the outdated economic growth models are leading to increased inequality and accelerated degradation of the natural environment, in addition to other risks. Thus, as we repair and build forward, we must reorient our values toward a scientifically informed understanding of earth systems, taking a whole-of-society approach with a clear intent to restore nature and reduce our footprint.

As we emerge from the global pandemic, this is the moment to shift incentives and investments away from unsustainable production and consumption patterns – business as usual – toward more nature-positive, low emission, and low polluting economic activities: decarbonisation, dematerialisation, and detoxification. This requires placing nature and climate concerns at the heart of all socio-economic recovery efforts, and bringing justice and equity at the forefront. Efforts to shape a new digital society should work toward closing the digital divide while simultaneously enabling shifts in production and consumption practices.

[8] GeSI & Deloitte, 2019. Digital with Purpose: Delivering a SMARTer2030

Business models and consumption patterns driven and, at present, served by the continuous growth model draw limited distinction between price and inherent value. This mindset is pushing us beyond the planet's carrying capacity. Ubiquitous features of online platforms, search engines, news feeds, targeted advertisements, suggested sites, and connections have become "hyper-nudge" mechanisms that increasingly determine what people read, what questions they are encouraged to ask, and what opinions and candidates they support.

As our global economy undergoes digital transformation, there are opportunities to 'hard code' environmental sustainability as a foundational feature. In doing so, we can fundamentally shift incentive structures – and use digital technologies to optimise for sustainability outcomes rather than ones that are solely profit-oriented.

We are seeing nascent efforts to embed environmentally minded values, goals, and metrics into existing digital technologies. To facilitate better supply chain tracking, environmental metrics have been increasingly built into the blockchain ecosystem.[9] Google has also adjusted its maps algorithm to show 'greener' options for transportation.[10] Even Amazon is responding to climate-based criticisms by beginning to highlight climate-pledge friendly products on its platform to nudge consumers toward better sustainability choices.

But rebuilding a compassionate, ecologically minded economic system without addressing inequality in all its forms would be self-defeating. Digital transformation is not simply a channel to speed up economic activities, nor one that by itself ensures long-term environmental health. It must also optimise social equality and collaboration, facilitate the creation of decent, green jobs, and promote greater inclusivity and diversity.

(2) Building sustainable digital infrastructure

Key message: Resilient and adaptive digital infrastructure is foundational for ensuring digitalization is benefiting the whole of society. Infrastructure must be co-created in a way that ensures universal access and participation and that can be powered in a sustainable and climate-safe way.

Digitalization is happening rapidly but unequally. Sixty percent of the world's population is now online. But 90% of those live in developed countries. In those developed countries, 80% of people are online, compared to only 20% in less developed countries.[11] Further, digitalization is contributing to a widening inequality, knowledge, and education gap between and within developed and less developed countries, or even within countries.[12] In OECD countries

[9] UNDP - Climate Change Adaptation More than just cryptocurrencies - using blockchain for climate action in agriculture

[10] Google, 2021 Redefining what a map can be with new information and AI

[11] United Nations, 2019. Digital Economy Report, 2019

[12] Qureshi, 2020. Inequality in the Digital Era

between 2001 and 2013, labour productivity among frontier firms – more likely to be digitally literate – rose by around 35%. Among non-frontier firms, that increase was only around 5%.[13]

Least developed countries have the greatest digital divide, representing a 32.9% inequality gap related to internet access. We live in a world where 90% of all jobs require some level of digital access.[14] At the same time, half the women on the planet today have no digital access.[15] In order to ensure sustainable livelihoods for all, bridging this digital divide is vital. Without addressing this gap, a quarter of the world's population will find itself unable to contribute digital environmental sustainability as producers or even consumers. Women and girls from early childhood to adulthood must have affordable, equal access to digital literacy education, content, and infrastructure to support their becoming not just consumers, but producers of technological innovations.

Research shows that small businesses in poorer nations suffered more during COVID-19 lockdown than their wholly digital counterparts.[16] This has spurred momentum to recognise digital infrastructure as a basic human right in our increasingly digitized society. And critically, access to a quality, affordable, and secure internet connectivity should be governed as a digital public good.

While we strive to reach universal internet connectivity, the question is whether we can continue to digitalize without exceeding the planetary boundaries. As mentioned previously, we have already crossed the thresholds of four of the nine planetary boundaries identified by earth systems scientists as critical to our stable sustainable existence on the planet. Unfortunately, the processes by which our digital infrastructure is currently developed, produced, powered, and disposed of is exacerbating our acceleration toward exceeding the threshold of the other planetary boundaries.

According to the European Framework Initiative for Energy & Environmental Efficiency in the ICT Sector, almost 10% of all energy used and 4% of carbon emissions in the environment come from ICT alone. As the world continues to digitize, the ICT sector will only grow. The tools and processes many associate with digitalization take up an inordinate amount of energy, stealthily increasing their usage in ways that too often go unnoticed.

Recent estimates put the ICT sector's carbon footprint at up to three percent of annual greenhouse gas emissions.[17] Bitcoin, heralded as the currency of the future, uses a form of blockchain based on extremely energy inefficient 'Proof-of-Works' algorithms. As a result, it consumed an estimated 50-70 terawatt hours of electricity in 2019 alone – about equivalent to the consumption of Switzerland or Belgium.[18] Further, new studies show that typical machine

[13] OECD 2016. The Best versus the Rest: The Global Productivity Slowdown, Divergence across Firms and the Role of Public Policy

[14] Plan International. Bridging the Digital Divide

[15] ITU, 2020. Measuring digital development: Facts and figures 2020

[16] UNCTAD, 2020. New survey shows COVID-19's impact on e-commerce in poorer nations

[17] ITU, 2020. Recommendation ITU-T L.1470

[18] IEA, 2020. Data Centres and Data Transmission Networks

learning processes can emit nearly 300,000 kilograms of carbon dioxide equivalent. That's about five times the lifetime emissions of the average American car, including the manufacturing process.[19]

2019 was also a record-breaking year for e-waste. In that year alone, 53.6 million metric tons of e-waste was produced. That's the equivalent weight of 125,000 Boeing 747 jumbo jets – more than all of the commercial aircraft ever manufactured. This incredible volume makes e-waste the world's fastest-growing domestic waste stream, fuelled primarily by higher consumption rates of electric and electronic equipment, short life cycles, and few options for repair.[20] Less developed countries in particular struggle with managing e-waste, as nascent or non-existent e-waste management infrastructure struggles to keep up with exploding use of digital devices.

As we shift our lifestyles away from fossil fuel dependence, our demand will increase for other sources of energy, primarily minerals like graphite, lithium, cobalt, and bauxite. Green technologies are more mineral intensive in their composition than traditional fossil fuel-based energy supply systems.[21] To meet the growing demand for green energy technologies, the production of some minerals could increase by nearly 500% by 2050.[22] At least 23 key minerals are critical to the development and deployment of solar panels, wind turbines, electric vehicles, and energy storage technologies. Substantial reserves of 18 key minerals are found in states with a high rank on the 2017 corruption perceptions index. Increased demand for minerals from these areas could amplify existing drivers of instability and cause significant environmental risks in mining locations.[23] Ultimately, this could stymie human development and potentially trigger a global backlash that undermines the growth of green energy technologies and support of digital technologies.[24]

To ensure the increasing demand for minerals does not exacerbate existing inequalities and fragilities, or cause new ones, careful attention must be paid to the ICT supply chains. Concerns have been raised about all stages of the supply chain – from mining in conflict zones to the long, transcontinental journeys that most rare earth minerals take from the ground into electronics.

(3) Shaping digital innovations toward a common vision

Key message: Digital innovations are not only "instruments" to solve sustainability challenges, but hold the potential to act as drivers of fundamental, deep systemic changes if they are based on a shared prosperity, responsibility, sustainability, solidarity and dignity. Sectoral planning is not enough, and a better understanding of the system as a whole is critical to identify critical drivers for change.

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[19] Hao, Karen, 2019. MIT Technology Review. 'Training a Single AI Model Can Emit as Much Carbon as Five Cars in Their Lifetimes.'

[20] GEM, 2020. The Global E-waste Monitor 2020, Quantities, flows, and the circular economy potential

[21] World Bank Group, 2017. The Growing Role of Minerals and Metals for a Low Carbon Future

[22] World Bank, 2020. Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition

[23] IISD, 2018. Green Conflict Minerals: The fuels of conflict in the transition to a low-carbon economy

[24] World Bank, 2017. The Growing Role of Minerals and Metals for a Low Carbon Future

Digital technologies can bring direct benefit to sustainability challenges. Smart manufacturing can contribute to the roll out and viability of **circular business models** by allowing products and components to be tagged, tracked, and traced throughout their entire life cycles. In a circular model, products are returned to the factory at end-of-life to be remanufactured, repaired, or refurbished, creating significant resource savings. By reducing the amount of materials used, or increasing their lifespans, costs can be decreased and emissions reduced.[25] According to recent reports, a more circular economy could cut emissions from heavy industry by 56% in the EU by 2050, and 45% of cumulative emissions from steel, cement, plastic, and aluminum production globally.[26]

How we adapt and take decisions in face of extreme uncertainty and abrupt impacts of climate change, especially in sub-Saharan Africa and Small Island Developing States (SIDS) presents an opportunity to embrace new technology and digital transformations. **Vulnerable populations** are most affected by the impacts of climate change, especially increased climate variability and extreme weather events. The need to improve real-time weather, water, early warning, and climate services in these countries is crucial to improving their resilience. Recent technology such as satellite and earth observations data, geographical information systems, digital technology for communications and other innovations in the field of weather forecasting can have profound impacts on disaster risk reduction, as well as contribute to more predictable food systems.

In addition to direct benefits, however, digital transformation has the potential to bring forward a **deeper, more inclusive systemic change**. For example, production, flow and consumption of energy is a critical and promising system where digitalization continues to drastically change the landscape and shape consumer behaviours. The energy sector today accounts for 40% of carbon emissions worldwide, and is expected to rise further as the global population grows and demand increases, including from digitalization.[27] The penetration of **renewable energy**, as we move away from fossil fuel based energy sources, will be crucial to achieving – and maintaining – targets for net-zero carbon emissions, or imagining a net-negative future.[28] Three key green technologies are critical for realising a net zero carbon future over this century based on renewable energy: wind, solar, and energy storage.[29] Solar PV and onshore wind are already the cheapest ways of adding new electricity-generating plants in most countries today.[30] With the dropping cost, if we're able to let new energy technologies develop at its early best rates of growth, we'll be able to cut energy-related emissions in half by 2030.[31] Smart grids, a 'digitalization' of the previous analogue grids, were the key enabler of decentralized electricity generation and new business models such as feed-in-tariffs, which unlocked a huge change in consumer behaviour. A concerted effort of technology innovation, policies and regulation,

[25] Exponential Roadmap 1.5, 2019. Exponential Roadmap Scaling 36 Solutions to Halve Emissions by 2030.

[26] PA. Enkvist, P. Klevnas, The Circular Economy–A Powerful Force for Climate Mitigation: Transformative Innovation for Prosperous and Low-Carbon Industry. Material Economics Sverige AB: Stockholm, Sweden (2018).

[27] World Bank, 2020. Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition

[28] Nature, 2021. Net-zero emissions targets are vague: three ways to fix

[29] World Bank, 2017. The Growing Role of Minerals and Metals for a Low Carbon Future

[30] IEA, 2020. Renewables 2020 Analysis and forecast to 2025.

[31] Exponential Roadmap 1.5, 2019. Exponential Roadmap Scaling 36 Solutions to Halve Emissions by 2030.

investments, and financial incentives resulted in a drastic increase of renewable energy sources.

Smart buildings, with automated heating, air conditioning, lighting, and other functions, can 'learn' the user patterns of a building and anticipate changes in advance. On a residential basis, smart thermostats save energy on heating and cooling by adjusting to people's habits. These could contribute to 2.5 gigatons of emission cuts by 2050.[32] With adequate support, including supportive policies, many cities could achieve an electrical grid mix of 50-70% renewables (mostly solar and wind with some other zero-emission generation sources) by 2030. While cities occupy just three percent of the Earth's land, they account for up to 80% of global energy consumption and 75% of global carbon emissions.[33] This reduction is crucial and necessary.

Digital technologies enabled drastically new ways of **connecting to the electrical grid**, too. Currently one billion people still lack access to electricity, 85% of which reside in rural areas.[34] In areas distant from the main grid, innovative new technology and processes, like the spread of mobile phone-enabled payment options, fintech solutions like end-user credit assessments, and new business models like pay-as-you-go have increased the potential for previously unfeasible off-grid electrification projects and investments.[35] This opened up new options to countries for reaching universal access, from a previously limited option which was 'grid connection'. Nigeria, for example, has implemented the largest minigrid programme in Africa, targeting 850 minigrids by 2025, with the goal of extending electrical services to 300,000 households and 30,000 enterprises in rural areas by 2023.[36]

The **food system** is one of the largest human pressures on the planet. A drastic change is required if we are to feed the growing population without exceeding planetary boundaries. Feeding and producing food for the global population accounts for 23% of annual greenhouse gas emissions. Nearly half of these – primarily livestock production and rotting food waste – are directly related to food choices we make as individuals.[37] One third of the 1.3 billion tons of food produced each year is lost or wasted.[38] These inefficiencies are unevenly distributed throughout the globe; higher-income countries waste almost as much food annually as the entire net food production of sub-Saharan Africa.[39] On the other hand, nearly 820 million people lack sufficient food.[40] Many millions more are part of a global trend in which traditional diets are replaced by

[32] Exponential Roadmap 1.5, 2019. Exponential Roadmap Scaling 36 Solutions to Halve Emissions by 2030.

[33] Cities – United Nations Sustainable Development, https://www.un.org/sustainabledevelopment/cities/

[34] World Bank 2020. Tracking SDG 7 - The Energy Progress Report 2020

[35] UNDP, 2018. Derisking Renewable Energy Investment: Off-Grid Electrification

[36] World Bank, 2019. Mini Grids for Half a Billion People: Market Outlook and Handbook for Decision Makers

[37] All facts in this paragraph from IPCC. Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. (2019).

[38] Food and Agriculture Organization of the United Nations, 2019. Key facts on food loss and waste you should know!

[39] W. Willett et al., Food in the Anthropocene: the EAT Lancet Commission on healthy diets from sustainable food systems. Lancet 2019; 393: 447–92. (2019).

[40] Food and Agriculture Organization of the UN. International Fund for Agricultural Development, UNICEF, World Food Programme, WHO. The state of food security and nutrition in the world. Rome: Food and Agriculture Organization of the UN (2018).

diets higher in foods from animal sources. If this trend continues, emissions from food consumption and production will nearly double by 2050.[41]

Digital technologies stand to hugely benefit the field of agriculture, in particular in regards to water efficiency and reducing the use of pesticides and chemical fertilisers.

- Agriculture has huge potential in productivity gain, water efficiency and reduction in pesticide and chemical fertilisers with a suite of digital technologies, such as precision input delivery, satellite monitoring, simulated ag trials, etc.[42,43,44,45]
- Propose systemic solutions-change in value chain and demand / supply prediction, decentralised business models that incentivise local producers

In making **data** available to us in new ways, digital technologies have opened up drastically new decentralised business models.[46] They have provided us with data that we were not able to access or comprehend before (like satellite imagery, IoT, and big data), given citizens the power to participate in scientific discovery, and presented opportunities for solving prominent problems in the last mile.

- Source early models of citizen science, New ways of environmental governance
- design principles -- interoperability, virtualisation, local, real-time talent, service orientation and modularity -- for potential transformation from machine dominant manufacturing to digital manufacturing.[47]
- Potential of IoT[48]
- The digital economy can actually help sustainability become simple, seamless and completely automated, removing the current levels of confusion, complexity and friction.
- Strengthen new city governance, augmented reality, modeling of traffic flow and urban infrastructure resilience, new ways of planning
- Planning - Revolutionised by digital visualisations, can help solve problems of sprawl, heat islands, and general inhospitableness.
- Supporting parallel advancements in net-negative technology, such as carbon capture and re-use.

Decentralised businesses, citizen empowerment, new ways of envisioning or modeling the future, and seamless flow of data, information and decisions can aid societies to make deliberate choices on these system changes. However this will not happen organically. Participatory forms of governance across all governance levels, where nations, industry leaders in digital innovation and representation from other stakeholders (like multilateral organisations,

[41] W. Willett et al., Food in the Anthropocene: the EAT Lancet Commission on healthy diets from sustainable food systems. Lancet 2019; 393: 447–92. (2019).
[42] https://doi.org/10.1016/j.njas.2019.100315
[43] https://doi.org/10.1162/glep_a_00566
[44] https://doi.org/10.17261/Pressacademia.2017.448
[45] NJAS-Wageningen Journal of Life Sciences, 90, p.100315
[46] Rifkin, Jeremy, 2014. The Zero Marginal Cost Society.
[47] https://doi.org/10.1007/s10845-018-1433-8
[48] https://doi.org/10.1016/j.jbusres.2019.12.035

human rights institutions, and more) can be brought into a dialogue in order to shape the direction of digital innovation, manage efforts to enhance diverse and mission-led innovation in various economies and geographic locations, and to ensuring equality in access to digitalization. Technology innovation, entrepreneurship, policies and regulation, consumer awareness, investment, and financial incentives need to move hand in hand toward a common vision.

Finally, the COVID-19 pandemic has illuminated the true extent of the gender divide. Women still disproportionately bear the brunt of childcare, forcing many to sacrifice career advancement to care for children at home as schools and daycares closed during lockdown. In academia, women published fewer papers than men during lockdown. In the US and Britain, mothers were more likely to lose or quit their jobs than fathers during lockdown.[49,50] In many less developed countries, lockdowns have kept girls home from school, sacrificing formal and informal education opportunities and the opportunity to be vaccinated.[51] A March 2021 UNICEF report warns that 10 million more girls are at risk of child marriage because of the pandemic.[52]

Digital technologies offer opportunities to overcome these inequalities with increased access to education and information, particularly in rural settings. Social media and online networks allow women to more easily connect, build action coalitions,draw attention, and demand accountability. However, a digital gender divide still persists within technologies themselves. As digital tools are designed primarily by men, gender biases are often transferred into their code, algorithms, and design. This has resulted in facial recognition that disproportionately mis-identifies women, in screening algorithms that disadvantage female applicants, and more.

To address these asymmetries and bridge the digital gender divide, we need funding mechanisms and tools supported by the public and private sector that ensure equity in gender access and representation at all levels of power. We also need to develop enabling, confidence-building environments where girls and women can safely acquire skills. Safety online is also an issue for LGBTQ+ and other marginalised communities.

But beyond safe spaces, we need to include members of marginalised communities not just as consumers, but producers of digital technologies. Globally, marginalised communities and women have less access to venture capital and startup funding. And finally, women at present represent only 28% of STEM workforce globally.[53] This gap is amplified even more when it comes to the digital jobs shaping our collective future. Promoting women's leadership requires enabling policies that build on gender analysis and ensure safe environments for learning and growth throughout education and career paths.

IV. An action agenda and commitment framework

[49] IFS, 2020. How are mothers and fathers balancing work and family under lockdown?

[50] Lofton, Olivia, Nicolas Petrosky-Nadeau, Lily Seitelman. "Parents in a Pandemic Labor Market," Federal Reserve Bank of San Francisco Working Paper 2021-04. https://doi.org/10.24148/wp2021-04

[51] The Economist, 2020. Covid-19 threatens girls' gigantic global gains

[52] Unicef, 2021. COVID-19: A threat to progress against child marriage

[53] AAUW, The STEM Gap: Women and Girls in Science, Technology, Engineering and Math

Our collective response to (1) climate change and environmental degradation and (2) the use and governance of digital technology will shape the future of humanity.

Our work now is to connect these two challenges and leverage digital technologies to recalibrate values, shift incentives, catalyse sustainable behaviours, and co-create the jobs of the future. How we tackle the challenge will play a critical role in whether we move toward a future where human development can progress in a way that is harmonious with the planet, or whether we choose to carry on with business as usual amid an environment of increasingly devastating crises.

Through multilateral digital cooperation we can harness the exponential power of digital technology to create a path forward that both eases the pressure on the planet and allows us to advance human development by closing the digital divide. It's important to remember that digital technologies are not ends in themselves – rather, they are only means for us to address existential threats like zoonotic diseases, climate change, and biodiversity loss. We can only successfully address these issues if we build infrastructure, standards, and algorithms with an eye toward ensuring positive environmental outcomes that are inclusive, equitable, and sustainable.

Deep collaboration between public and private sectors will be necessary in the development of digital public goods and in the sustainability transformation. New partnerships need safeguards and new business models to ensure they are conducted in the public interest with maximum transparency. The twinned projects of achieving net-zero and closing the digital divide must be data-led. The ability to track the environmental footprint of increased use of digital technologies, as well as the progress we make in closing the digital divide, is critical to transparent and agile workflows. Systematic changes and new incentives are needed to link digital transformation to environmental sustainability and human development. In the next two years, we believe that these changes can be catalysed by organising our collective response around six main challenge areas. Each of these challenges is necessary to address as part of an acceleration plan for building a digital planet for sustainability.

Key values (for discussion)

The common values we propose to aim for are:

1. Equity, dignity, and justice
2. Adjusting our collective valuation of social, natural, human, and financial capital Acting on the belief that society has the power to shape technology and innovation
3. Insisting on transparency in digital algorithms and business models
4. Acting on the belief that digital technologies can ultimately empower people and nude them toward more sustainable lifestyles
5. Achieving deep collaboration between public and private sectors and accepting the need to create business models for digital public goods

6. Progress toward a decentralised and distributed governance framework to keep pace with the speed of digital technology

*Priorities for transformation **(for discussion)***

- Data
- Finance
- Incentives
- Access
- Capacity Building
- Enabling Conditions

V. Seizing the opportunity

The lesson from the COVID-19 crisis holds true for the environmental sustainability crisis we face. With international trade, globalised travel, and cross border migration, no nation will make it on their own. No one is safe unless we are all safe.

The tools of digital transformation have the potential to make our predictive models and visualisations more visceral and engaging. This will allow us to understand the crises we face in a context of compassion rather than quantification. The task is now to manage the change together so that marginalised voices are considered, engaged, empowered, and employed – rather than excluded – from the future we envision in this paper. We must use digital tools to compile better data sets than the ones we've used until now, and rectify the policies and programmes we've built on this unsteady foundation.

The content available through these technologies must be accurate, open, and universally accessible to ensure the technology itself does not become a source of inequality. We should be aware that the internet – now fundamental as the conduit of dialogue, exchange, and information – has fundamentally changed since its inception. Pioneered by its founders as open, free, and with universal infrastructure and standards, it has now become fragmented by computer protocols that increasingly differ by company and by country. The priorities advocated in this report would best be served by a reversion to the internet's original democratic designs.

Markets are essential to progress because they can identify, deliver, and distribute solutions to society's problems as well as supply products in general. But the market is not an end in itself. Markets are tools for society; platforms or arenas where transactions happen. For markets to serve our best interests, they need rules based on common values about how the transactions work and how the market operates. When a market's rules enable particular interest groups to maximise their benefits, and for the market itself to self-perpetuate, the market is exploiting the society that sponsors them.

When, instead, markets are based on the values proposed by Mark Carney and others – responsibility, resilience, fairness, and sustainability – they can become open exchange platforms for a society rather than predatory gambling dens. The actualisation of these values, as well as solidarity, dynamism, and humility, would make markets work to strengthen the integrity of the society that supports them. It would also inspire confidence in the people and institutions that participate in them.

Together, the seven values that Carney presents promote compassion, understanding, and determination – ideas that proved their worth during the COVID-19 pandemic. We came to understand that in a pandemic, no one is really safe until everyone is safe.

As all economic transactions are increasingly digitalized, we can harness this opportunity to fundamentally encode environmental sustainability values, goals, and metrics within the algorithms, platforms, and applications of the digital economy. We can use digital technologies to optimise for sustainability outcomes and we can finally make sustainability simple, seamless, and automated.

When we say our response to environmental crises and the adoption of digital technology will determine the future of humanity, the choice is obvious about what future that should be – a better one than we have today. In our acceleration plan, the six challenges mold the digitalization goals to address environmental complexities with place-based, appropriate solutions that tackle societal inequities.

So this is how we design our digitalized future: in a manner so that the process, the means, and the ends promote those objectives we already agree on. These are social justice, human rights, economic equity, gender equality, resource conservation, biological integrity, environmentally sound technological advances, and opportunities that allow communities and individuals to follow their own aspirations. Ultimately, digital technologies are simply means to give people more freedom to make informed choices about how they live their lives. The challenge is to drive digitalization in a way that lets them do so while also contributing to a healthy planet and sustainable civilisation.

The views in this paper represent the contributions from a core group of authors from the following organisations:

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